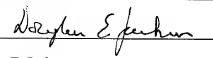


PCO #

Customized FORM PTO-1390		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY DOCKET NO. P07210US00/KRK	
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>				U.S. APPLICATION NO. <b>09/831962</b>	
INTERNATIONAL APPLICATION NO. PCT/F199/00952		INTERNATIONAL FILING DATE 17 November 1999		PRIORITY DATE CLAIMED 17 November 1998	
TITLE OF INVENTION: ADAPTIVE MODEM AND METHOD FOR ADAPTIVE ELECTION OF MODULATION...					
APPLICANT(S) FOR DO/EO/US: LALLO et al.					
Applicant herewith submits to the US Designated/Elected Office (DO/EO/US) the following items and other information:					
<div style="font-size: small;"> <input checked="" type="checkbox"/> 1. This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.  <input type="checkbox"/> 2. This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 USC 371.  <input type="checkbox"/> 3. This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 USC 371(b) and PCT Art. 22 and 39(1).  <input checked="" type="checkbox"/> 4. A proper Demand for International Preliminary Examination was made by the 19<sup>th</sup> month from the earliest claimed priority date.  <input checked="" type="checkbox"/> 5. A copy of the International Application as filed (35 U.S.C. 371 (c)(2))  <div style="margin-left: 20px;"> <input type="checkbox"/> a. is transmitted herewith (required only if not transmitted by the International Bureau).  <input checked="" type="checkbox"/> b. has been transmitted by the International Bureau.  <input type="checkbox"/> c. is not required, as the application was filed in the United States Receiving Office (RO/US).  <input type="checkbox"/> 6. A translation of the International Application into English (35 U.S.C. 371(c)(2)).  <input type="checkbox"/> 7. Amendments to the claims of the International Appln. under PCT Article 19 (35 USC 371 (c)(3))  <div style="margin-left: 20px;"> <input type="checkbox"/> a. are transmitted herewith (required only if not transmitted by the International Bureau).  <input type="checkbox"/> b. have been transmitted by the International Bureau.  <input type="checkbox"/> c. have not been made; however, the time limit for making such amendments had NOT expired.  <input type="checkbox"/> d. have not been made and will not be made.  <input type="checkbox"/> 8. A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).  <input checked="" type="checkbox"/> 9. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).  <input type="checkbox"/> 10. A translation of the annexes to the Int'l Prelim. Exam. Report under PCT Article 36 (35 U.S.C. 371(c)(5)).  <b>Items 11. to 20. below concern document(s) or information included:</b>  <input type="checkbox"/> 11. An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.  <input type="checkbox"/> 12. An Assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.  <input checked="" type="checkbox"/> 13. A <b>First preliminary amendment</b>.  <input type="checkbox"/> 14. A Second or Subsequent preliminary amendment.  <input type="checkbox"/> 15. A substitute specification.  <input checked="" type="checkbox"/> 16. A change of power of attorney and/or address letter.  <input type="checkbox"/> 17. A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 &amp; 35 USC 1.821-825.  <input type="checkbox"/> 18. A second copy of the published international application under 35 USC 154(d)(4).  <input type="checkbox"/> 19. A second copy of the English translation of the international application under 35 USC 154(d)(4).  <input type="checkbox"/> 20. Other items or information:  <div style="margin-left: 20px;"> <input type="checkbox"/>  <input type="checkbox"/> </div> <input type="checkbox"/> A copy of the Notification of Missing Requirements under 35 U.S.C. 371.  <input type="checkbox"/> In the event that a petition for extension of time is required to be submitted herewith, and in the event that a separate petition does not accompany this response, applicant hereby petitions under 37 CFR 1.136(a) for an extension of time of as many months as are required to render this submission timely. Any fee is authorized in 17(c). </div> </div></div>					
Date: 16 May 2001					

U.S. APPLICATION NO. <b>097831962</b>		INTERNATIONAL APPLICATION NO. PCT/FI99/00952		ATTORNEY DOCKET NO. P07210US00/KRK	
<b>X 21. The following fees are submitted:</b> <b>X Basic National Fee (37 CFR 1.492 (a) (1)-(5):</b> <div style="margin-left: 20px;"> <input checked="" type="checkbox"/> Neither Int'l Prelim. Exam. fee nor Int'l Search fee paid to USPTO \$1000  <input type="checkbox"/> Search Report has been prepared by the EPO or JPO \$ 860  <input type="checkbox"/> No Int'l Prelim. Ex. fee paid to USPTO but Int'l Search fee paid to USPTO \$ 710  <input type="checkbox"/> International preliminary examination fee paid to USPTO \$ 690  <input type="checkbox"/> Int'l Prelim. Ex. fee paid to USPTO &amp; all claims satisfied PCT Art. 33(1)-(4) \$ 100         </div>					<b>CALCULATIONS</b> <small>PTO USE ONLY</small>
<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>					<b>\$ 1,000.00</b>
<input type="checkbox"/> Surcharge of \$130 for furnishing the oath or declaration later than from the earliest claimed priority date (37 CFR 1.492(e)).					<input type="checkbox"/> 20 mos. \$ <input type="checkbox"/> 30 mos. +
<b>CLAIMS</b>	<b>NUMBER FILED</b>	<b>NUMBER EXTRA</b>	<b>RATE</b>		
Total Claims	- 20 =		<b>X \$18 =</b>	\$	
Independent Claims	- 03 =		<b>X \$80 =</b>	\$	
<input type="checkbox"/> Multiple Dependent Claim(s) (if applicable)			+ \$270 =	\$	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$ 1,000.00</b>	
<b>X Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.</b>					<b>\$ 500.00</b>
<b>SUBTOTAL =</b>				<b>\$ 500.00</b>	
<input type="checkbox"/> Processing fee of \$130 for furnishing the English translation later than from the earliest claimed priority date (37 CFR 1.492(f)).					<input type="checkbox"/> 20 mos. \$ <input type="checkbox"/> 30 mos. +
<b>TOTAL NATIONAL FEE =</b>				<b>\$ 500.00</b>	
<input type="checkbox"/> Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40 per property					<b>\$</b>
<b>TOTAL FEES ENCLOSED =</b>				<b>\$ 500.00</b>	
<i>Amount to be</i>				<i>Refunded</i>	\$
				<i>Charged</i>	\$
<b>X a. A check in the amount of \$ 500.00 to cover the above fees is enclosed.</b> <b>b. Please charge my Deposit Account No. 12-0555 in the amount of \$ to cover the above fees.</b> <b>X c. The Commissioner is hereby authorized to charge any additional fees required or credit overpayment to Deposit Account No. 12-0555.</b>					
<b>Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</b>					
SEND ALL CORRESPONDENCE TO:  <b>Kevin R. Klein</b>  At the address (below) of <b>CUSTOMER NO. 00881.</b>  <b>LARSON &amp; TAYLOR, PLC</b> <b>1199 NORTH FAIRFAX ST.</b> <b>SUITE 900</b> <b>ALEXANDRIA, VA 22314</b>			SIGNATURE:  <hr/> NAME: Douglas E. Jackson  REG. NO.: 28,518  PHONE NO.: 703-739-4900  Date: 16 May 2001		

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent

In re patent application of: LALLO et al.

New U.S. Application

Based on PCT/FI99/00952

Filed: 16 May 2001

For: ADAPTIVE MODEM AND METHOD FOR  
ADAPTIVE ELECTION OF MODULATION MODE

Docket No.:

P07210US00/KRK

PRELIMINARY AMENDMENTAssistant Commissioner for Patents  
Washington, D.C.

S I R:

Prior to examination, please amend the above-identified application as follows.

IN THE CLAIMS:

A clean version of all amended claims is provided herewith in **Attachment A**. It will be noted that claims 3, 4 and 6 have been amended relative to the previously provided version as shown by the marked up version thereof in **Attachment B** provided herewith.

REMARKS

By this Amendment, the claims have been rewritten to reduce the multiple dependencies.

Further and favorable action is solicited.

Respectfully submitted,

Date: 16 May 2001

By: Douglas E. Jackson  
Douglas E. Jackson  
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## ATTACHMENT A

### Clean Replacement/New Claims

*Following herewith is a clean copy of each claim which replaces each previous claim having the same number.*

3. (Amended) Adaptive modem according to claim 1 where the transmitter is a radio transmitter and the receiver is a radio receiver and where the modem includes a radio interface unit characterized in that the modem unit includes a program change function which makes it possible to use in spread spectrum mode over the bandwidth desired.

4. (Amended) A method to select the modulation mode adaptively according to claim 1 for each communication route of the adaptive modem, characterized in that the transmitted modulations and modulation methods are selected to different waveforms according to the principle that in reception we get by calculations the wanted or the maximal selectivity of transmitter carrier, amplitude and phase of the modulated waveforms using the algorithm developed from the Fourier Transform and using the wanted sample frequency for the waveforms in data transmission over the telecommunication network interface unit or over the radio interface unit.

6. (Amended) A method according to claim 4 characterized in that over the telecommunication network or over the radio channels a message is transmitted as a combined calculated and coded sum waveform of several different waveform

modulations which are in reception detected to waveforms and using the code information decoded as a message.

## ATTACHMENT B

### Marked Up Replacement Claims

*Following herewith is a marked up copy of each rewritten claim.*

3. (Amended) Adaptive modem according to claims 1 ~~and~~ 2 where the transmitter is a radio transmitter and the receiver is a radio receiver and where the modem includes a radio interface unit characterized in that the modem unit includes a program change function which makes it possible to use in spread spectrum mode over the bandwidth desired.

4. (Amended) A method to select the modulation mode adaptively according to the claim ~~one~~ 1 for each communication route of the adaptive modem, characterized in that the transmitted modulations and modulation methods are selected to different waveforms according to the principle that in reception we get by calculations the wanted or the maximal selectivity of transmitter carrier, amplitude and phase of the modulated waveforms using the algorithm developed from the Fourier Transform and using the wanted sample frequency for the waveforms in data transmission over the telecommunication network interface unit or over the radio interface unit.

6. (Amended) A method according to claims 4 ~~and~~ 5 characterized in that over the telecommunication network or over the radio channels a message is transmitted as a combined calculated and coded sum waveform of several different waveform modulations which are in reception detected to waveforms and using the code information decoded as a message.

### Adaptive Modem and Method for Adaptive Election of Modulation Mode

The invention is focused on the adaptive modem for data transmission and it is defined in the introduction part of the claim one.

In known data modems fixed frequencies, phases and amplitudes are used. In symbol transmission the information corresponds to waveforms according to the different modulation methods. Each waveform means thus one or several bits (binary digit). Table 1 shows ITU-T standard modems /1/. In the table a symbol equals one, two, etc maximal six bits (64-QAM). In these modems a symbol corresponds one frequency (carrier), one certain phase of the carrier frequency or some amplitude of the carrier frequency on the communication line. Modems are used in all analogy transmission channels for data transmission including radio channels. Restrictions of the technology described above are:

- It uses one carrier frequency, according to the table mostly 1800 Hz.
- Maximal 6 bits correspond to the certain waveform, thus there are a limited number of waveforms to present different symbols, according to the table we have maximal 64 different symbols as a 6 bit presentation with 64-QAM modulation,
- Bandwidth is adjusted to the traditional 300 – 3400 Hz analogy telephone network, according to the table and study the old fashioned FSK technology made slow 1200 bit/s V.23 modem has the narrowest bandwidth 900-2500 Hz.

Nowadays information technology produces only digital two-level data (0 or 1). The need to transmit data has caused the evolution of digital telecommunication networks /2/. The public opinion is thus in digital telecommunication using optical or fibre cables, where this digital on/off transmission is sufficient. Study associated with radio communications and digital telecommunication ISDN phones has developed digital modulation methods /3/, where the digital state (0 or 1) must be transmitted in analogy form.

Common modems have a very limited number of allowed frequencies, phases (for example 8) and amplitude values, Table 1. A disadvantage of present modems is the limited operational range focused to the certain telephone bandwidth or on the other hand range focused the certain radio equipment and channel. They cannot adapt to different type of channels for example the narrower than standard telephone or radio channel or on the other hand the broader bandwidth. Using present modems we cannot have fast data transmission or proper speech or picture transmission.

The limitation of the present ISDN technology is the fixed standard communication and speed of B-channel 64 kbit/s between the subscriber and the exchange /4/. The service offers two B-channels and one C-channel 16 kbit/s.

The adaptive modem can handle much more frequencies, phases and amplitudes than common



modems in generation of different waveforms. The adaptive modem is not limited to a fixed modulation method but it adapts to the possibilities of the transmission channel in use. Characteristic for the invention is what is presented in the claims.

Table 1 ITU standard modems /1/ and /3/

Year	Recommendation	Bit rate bit/s	Spectrum Hz Measured	Carrier frequency Hz	Symbol rate baud	Modulation
1964	V.21	300			300	FSK
1964	V.23	1200	900 - 2500	1300, 2100	1200	FSK
1968	V.26	2400	900 - 2700	1800	1200	4-DPSK
1972	V.26 bis	2400	900 - 2700	1800	1200	4-DPSK
1976	V.27 ter	4800	800 - 2900	1800	1600	8-DPSK
1976	V.29	9600		1700	2400	16-QAM
1980	V.22	1200	600 - 2900	1200, 2400	600	4-DPSK
1984	V.22 bis	2400	600 - 2950	1200, 2400	600	16-QAM
1984	V.32	9600	300 - 2950	1800	2400	16-QAM
1984	V.33	14400	300 - 3200	1800	2400	32-QAM
1994	V.34	28800		1800	2400 2800 3000 3200 3429	16-QAM 32-QAM 64-QAM
	version 96	31200 33600				

The invention includes that waveforms used correspond to the rich symbol file, in theory almost unlimited number of symbols, thus we get the following advantages:

- The transmission speed of the telephone subscriber over the Internet or over the common telecommunication network is higher than the present ISDN 64 kbit/s or the modem 33.6 kbit.
- The data communication is much faster because waveforms in the adaptive modem algorithm correspond to a larger number of bits than presently. Using the equivalent symbol rate we can transmit much more bits than nowadays.
- Based on the adaptive performance the modem suits to most telecommunications systems in use and the bandwidths their communication channels provide (including radio and telecommunication channels), which is a quality the common modems cannot provide.

- The adaptation to the communication channel available is made by software without any change in the mechanic structure or interconnection of the adaptive modem. In the same way the operation mode can be changed on the radio frequencies. By the parameter changes the selections like modulation method, transmission speed and quality of service (bit error rate) are made.
- The adaptive modem fits its performance to each available channel and transmission environment by optimising automatically the functions according to the criterion selected. Criteria may be for example the channel bandwidth and frequencies, the bit error rate allowed during telecommunication, transmission speed needed, encryption algorithm, error correction etc. Modem uses for waveform generation a calculation algorithm and digital to analog transform and an interface unit between the processor and the telecommunication network. In reception we need similarly an interface unit, an analogy to digital transformer, a calculation algorithm for waveform detection and a processor. Between the computer and the modem we have a standard connection.

In the following the invention is explained more exactly referring to the enclosed figures, where

Figure 1 is a block diagram of the software modem card.

Figure 2 presents the amplitude modulation.

Figure 3 presents the phase modulation.

Figure 4 presents the amplitude and phase modulation.

Figure 5 presents the sum waveform of several different frequencies.

Figure 6 is a block diagram of the modem card of the radio modem.

Figure 1 block diagram left side presents a computer PC, where the software modem interfaces ISA-, PCI- or USB-bus. The modem part on the card gets the power, data- and address signals and the interruption signals through the interface. The modem card has buffer circuits for the signals.

## SIGNAL TRANSMISSION

The main component of the modem part is the signal processor, which gets the on process or the transmitting data from the PC data bus. In reception the signal processor feeds data to the PC data bus. The processor also partly takes care of side tones and echo cancelling. The modem software is loaded through the PC data and address bus. Memory is EEPROM type, which can be programmed electrically.

The modulated digital data from signal processor is transformed to analogy by digital to analog converter. Its analogy voltage message is connected to an opto isolator unit, which separates galvanic the telecommunication network interface from the converter.

The output voltage of the signal is lead to the stepwise controlled amplifier the gain of which is regulated with resistors proper for the telecommunication network. The output voltage of the

amplifier is connected to the resistor bridge from where the signal proceeds through a rectifier to incoming call identification and overvoltage protection circuit. From there the modem signal proceeds into the two-wired telecommunication network.

## SIGNAL RECEPTION

The modem signal from the telecommunication network goes through the incoming call identification and the overvoltage protection circuit to the rectifier, from where the signal is connected to the resistor bridge. The function of the bridge is to build so called side noise free connection or let the incoming modem signal from the telecommunication network pass but reject at the same time the outgoing modem signal to the telecommunication network to get connected to the amplifier of the reception.

The incoming modem signal proceeds automatically to the level locking amplifier, which identifies the signal magnitude and after that locks the proper amplification factor. This adaptive action assists the error free function of the reception especially then, when the received signal levels are weak. From the amplifier the signal proceeds through the opto isolator unit to the analog digital converter. It converts the analog voltage message into digital for the signal processor. The signal processor detects or demodulates from the digital signal a message, which is lead to the PC data bus.

## OTHER PARTS

The function of the call identification and overvoltage protection circuit is to identify the call from a B-subscriber and inform the call to the PC through the opto isolator unit. The function of the unit is also connect through the transmitting and the receiving modem signal. The overvoltage protection rejects the flashing or other high voltages to cause damage to the telecommunication network interface unit. If the PC user is an A-subscriber the control signal is connected through the opto isolator to line interface, and then the modem card is galvanic connected to the telecommunication network. After that the signal processor builds a call sequence to the B-subscriber, and then the connection is ready. The blocks of the interface parts of the telecommunication network get the power from the interface unit power, which does not load the telecommunication network and its power feeding blocks.

## GENERATION OF TRANSMISSION WAVEFORM

The adaptive modem applies the Discrete Fourier Transform /5/-/6/ both in the generation of the waveform and in its detection algorithm. The generally known Fourier transform is applied in some measuring equipment as a Fast Fourier Transform (FFT), where we cannot exploit all the transmitted samples in data transmission but only in powers of two thus: 2, 4, 8, 16, 32, 64, 128,

256, 512, 1024 etc. The invention like adaptive modem applies the Discrete Fourier Transform and can use all sample numbers encountered in practical applications 8, 9, 10, 11, 12, ... 16, ... 32, ... 100, ... 1024, ... etc, thus we can talk about the adaptive function according to the number of the mark (symbol) length. We have to mention that the transmitted symbol contains N samples, and thus we get the time domain length of the symbol and symbol rate. The possible sample rate (Sound blasters max. 45 000, dsp 120 000, USB 12 000 000 samples /s) of the available technology has effect on the symbol rate. The adaptive modem has not been possible before the technology had developed to the present level.

According to the coding method of the analogy signal like speech we get one (adaptive delta modulation), two or more for example 8 (PCM) bits. The adaptive modem combines the bits into symbols, which can have 1, 2, 3 or more bits, a very large number of bits. The adaptive modem can transmit the coded speech regardless of the coding method used.

With the coded text the adaptive modem offers an analogy transmission counterpart for ASCII-code. The equal standard codes get their analogy standard counterparts, which is not realised in modems on the market. Coding can be made instead of bit coding as present with different symbols saved in the computer memory into the analogy transmission mode using the adaptive modem. We will develop new standards for the analogy coding of different digital symbols, text, picture, map etc.

In figure 1 we have a low sine wave 0-bit and a high wave is 1-bit. In figure 1 we present only amplitude modulation. It is usual that fast direct cable connections use digital transmission, where 1-bit is a voltage value over a threshold and 0-bit is the voltage value below that threshold. In figure 1 we present the letter "H" ASCII code with the most trivial amplitude modulation. It has only one wavelength (18 samples), no phase changes and only one bit in every wavelength. In figure the vertical axis present the voltage and the horizontal axis is time. White vertical lines are at every tenth sample.

Figure 2 is the same ASCII code and the letter "H" is presented by the pure phase modulation. If the wave has no phase change in the beginning, it is 0-bit. If the change is 180 degrees, it is interpreted as 1. In figure 2 we have thus H = 01001000.

If we combine the figures 1 and 2 we get the presentation of figure 3 for amplitude and phase modulation. A most simply situation. In figure 3 every wavelength transmits two bits. The first one is amplitude modulated and the second is phase modulated. In figure three we have a message "Ha".

If we are satisfied with the figure 3 presentation, we do not get a very fast line transmission speed. If we use instead of one wave (carrier) four waves (carriers) as follows: the second wavelength is  $\frac{1}{2}$  times the first and the third is  $\frac{1}{4}$  times the first and the fourth is  $\frac{1}{8}$  times the first and we allow 16 states for amplitude heights and 16 different phase change states, we get the situation in figure 4.

In figure 4 we have quite fast signal, which we can detect with the Discrete Fourier Transform (DFT). We are looking the sum waveform of several different frequencies. The transmitting modem processor has generated the sum waveform using general algorithms.

According to the transmission channel quality we can use for example 20 different frequencies at the same time, 8 bits using one wave (carrier) and modulation method. The number of samples in the basic (first) wavelength (carrier) can be for example 64 and the lowest waveform can be selected according to the limits set by the channel. Still the frequencies can be compressed for example into 50 Hz channels and we can still calculate the detection result with the algorithm derived from the Fourier transform, this means that all the waveforms included in the sum waveform can be detected with the modem processor unit.

#### DESCRIPTION OF THE ADAPTIVE RADIO MODEM

The block diagram of the software radio modem card is presented in figure 5. The modem card is connected to the PC with ISA, PCI or USB bus according to the version. The modem part in the card gets the power, data and address signals and interruption signals via bus. For the signals we have buffer circuits on the modem card.

The main component on the modem part is the signal processor, which get the transmitting data from the PC data bus. The processor is also available for the use of the spread spectrum technology. The signal processor works using a program memory. The modem software is loaded via the PC data and address bus. The memory is EEPROM type, which can be electrically programmed.

The modulated digital data from signal processor is converted to analogy with a digital to analogy converter. Its analogy voltage message is connected to the step adjustable amplifier, the gain of which can be set with resistors if needed to proper value for the modulator. The output voltage of the amplifier is connected to the modulator, from where the signal proceeds to the RF or radio transmitter. The function of the modulator is to put the transmitting data signal into the high frequency carrier using amplitude or/and phase modulation. The RF transmitter works as the amplifier for the high frequency and modulated carrier, from where the signal is lead to the transmitting antenna (RX-TX-antenna).

The reception of the signal is made by leading the high frequency modem signal from the receiver antenna to the RF-receiver, which works as the amplifier for the high frequency signal. The RF-receiver feeds the demodulator or discriminator, where the data signal is separated from the high frequency carrier. The modem signal proceeds further automatically to the level locking amplifier, which identifies the magnitude of the signal and after that it locks the proper gain factor. This adaptive effect helps the error free function in the reception when the signal levels are weak. The signal proceeds further to the analogy digital converter. It converts the analogy voltage message into

digital for the signal processor. The signal processor in turn detects or demodulates the message from the received digital signal. The message is put to the PC data bus.

The function of the call identification circuit is to identify the incoming radio data message and inform it to the PC. Then PC can be ready for the data signal processed by the signal processor. When PC sends data by radio, a control signal is connected to the transmission interface, and then the RF-transmitter is turned on. After that the signal processor generates the data signal for the transmission.

A modem system according to the presented principle may be both a data modem needed for data transmission and a digital radio where broadband- or so called frequency hopping transmitter is needed and a detector needed in the receiver. The mark, data or symbol waveforms are generally ready saved in the memory and they are detected by calculations with the algorithm based on the Fourier transform. Here we need a signal processor and memory circuits and the software saved in the memory circuit. The essential part of the modem is the interface, by which the program made or in the memory saved waveform according to the transmitted symbol etc is transferred to the telecommunication network or to the radio channel. The applied study of the telecommunication technology, digital signal processing, computer programming and present electronics and signal processors and analogy-to-digital converters in the adaptive modem creates a whole system, which guarantees the transmission speed faster than the present (common) speed. The (data) transmission speed can be adjusted according to the situation. It is rejected only through the bandwidth available, the signal-to-noise present and the level of the information technology and electronics at the moment.

In the patent application presented adaptive modem is much faster than the known standard modems mentioned in the request according to the tests already made. In the known modems the digital data transmission is generated already in the telephone equipment (ISDN phone) or in the first telephone exchange at the other end of the xDSL-subscriber line (no end-to-end principle). The adaptive modem is quite different to that. It is designed to work:

- Over narrow voice transmission lines by end-to-end principle and using complex even arbitrary selectable waveforms according to each need.
- Over existing different analogy channels as modems using analogy transmission lines or even using present analogy channels which are made digitally (ISDN phone) as a faster data transmission alternative for the standard modems. Design principles are exceptional compared to the common data modem design. The function of the adaptive modem is based on the generally known Fourier transform and series theory made by Joseph Fourier (1768-1830). According to the digital signal processing principles the invention uses the Discrete Fourier Transform based calculation algorithm for the calculation of the amplitude and the phase. This makes it necessary to sample the analogy signal in reception and to decode the symbol with the calculation algorithm based on the Discrete Fourier Transform. The known signal processing

and spectrum calculation equipment solutions use the Fast Fourier Transform (FFT) but the adaptive modem uses the Discrete Fourier Transform as a basis for the design of the signal detection and calculation algorithm. This feature is a major part to prove the adaptive modem a real invention and shows its difference to the common designs.

For every carrier used in the multi carrier technology we have calculated in real time their amplitude and phase. So we can detect the transmitted symbol from the so-called signal constellation. The adaptive modem can easily detect more complex signal constellations than the present, in-use, standard or otherwise common modems. We can mention one example of these kind of waveforms  $n$  times 1024-QAM. Here  $n$  means the number of carriers. The waveform can be adapted to the possibilities offered by the channel, it is - the allowed signal power dynamic range, amplitude max and min limits in volts - the frequency max - min values in Herz - the smallest frequency selectivity in Herz - the smallest amplitude step and - the smallest phase difference.

The achieved data rate can be selected partly according to the above but also by selecting the sample rate and the sample number in the symbol and the resulting symbol rate  $B_d$ . These are also some factors which greatly proves the adaptive modem is a real invention and different from the common generally known.

Based on this we have designed a computer assembly language calculation algorithm, which can detect carriers, their amplitudes and phases or detect complex waveforms. Modems having the same functionality is neither presented in publicity nor standardised or known to exist. Thus the adaptive modem is suitable to use over the narrow bandwidth better than any known modem. Examples of these channels are all international over telecommunication network working connected telephone lines, radio telephone connections (NMT, GSM, satellite phone and new voice radio communication systems), military radio communication over different frequency bands (HF, VHF, UHF, etc). The adaptive modem works not only over the narrow band but also as a broad band modem. This is also a factor which greatly proves the adaptive modem is a real invention and different from the common generally known.

Because the computer is interfaced with the radio and the telecommunication network, thus we have designed interfaces for the modem. The interface is a part of the waveform receiver and it includes the signal manipulating circuits needed. The complex waveforms need a very exact level control and synchronism. With the transmission and reception algorithms the system is a complete "adaptive modem" as described in the claim document. This is also a factor which greatly proves the adaptive modem is a real invention and different from the common generally known.

Because the adaptive modem is a method, which uses complex waveforms and each waveform uses several bits in a symbol and the number of bits is much greater than any known narrow voice

band data modem can do, the adaptive modem has a better data transmission rate than common modems.

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Applications,  
Prentice Hall, Englewood Cliffs, New Jersey, 1995.



# CLAIMS

1. Adaptive modem, which comprises

- 5 - a modem part which having transmitter and receiver units both using digital signal processing and a control unit needed for the modem functional control,  
- a tele- and radionetwork interface part having interfaces and signal amplification and waveform shaping units needed in transmission and receiving process,  
- a computer bus interface, and
- 10 - analysis of line response based on trigonometric or exponential calculation loops, correction algorithm and control parameters,  
**characterized in** that digital signal processing in the adaptive modem includes a Discrete Fourier Transform (DTF) calculation algorithm as the modem receiver/  
transmitter for adapting the modulation of the transmitter and receiver optimal with said  
15 algorithm in respect to the data transmission speed, bit error rate and/or bandwidth of the communication channel.

2. Adaptive modem according to claim 1 **characterized in** that the modem comprises a program, said program being used for the receiver operation mode change wherein the receiver is being able to detect different digital modulations generated by the transmitter like modulations based on different symbol lengths, different numbers of bits in symbol, several simultaneous carriers (multi carrier) or different combinations of several  
20 amplitude levels and phases in purpose specially to speed data communications using ordinary telephone lines.

3. Adaptive modem according to claim 1 or 2 where the transmitter is a radio transmitter and the receiver is a radio receiver wherein said modem includes a radio interface unit  
**characterized in** that the modem unit comprises a program change function calculated with DFT for allowing to use in spread spectrum mode over the bandwidth desired.

4. Method for selecting the modulation mode adaptively according to the claim 1 for each communication route of the adaptive modem **characterized in** that the transmitted waveforms (modulations and modulation methods) are selected according to such a principle that in reception there are by calculations set the wanted selectivity of

the transmitted carrier frequency, the wanted amplitude selectivity and the wanted phase selectivity for the modulated received waveforms using the Discrete Fourier Transform with the adaptively selected number of samples in the receiving and sending process of waveforms over the telecommunication network interface unit or over the radio interface unit of the adaptive modem.

5. Method according to claim 4 **characterized in** that in the method each bit, several bits, ASCII character, symbol, data, message, speech or for example picture (collection of bits) will correspond a specific waveform adaptively as a part of the modulation wherein the Discrete Fourier Transform, which allows the use of any sample number in the symbol (collection of bits) detection, thus performing the adaptive demodulation/modulation (adaptive modem) functions, which in turn with an adaptively selected sample rate produces the adaptive symbol rate or as a result the adaptive bit rate which thus can be set optimally according to the channel parameters (bandwidth, S/N, jitter, multi path fading) or other requirements (BER).

6. Method according to claim 4 or 5 **characterized in** that a message is transmitted over the telecommunication network or over the radio channels as a combined calculated and coded sum waveform of several different waveform modulations which in the reception are detected to waveforms and decoded as a message using the code information.

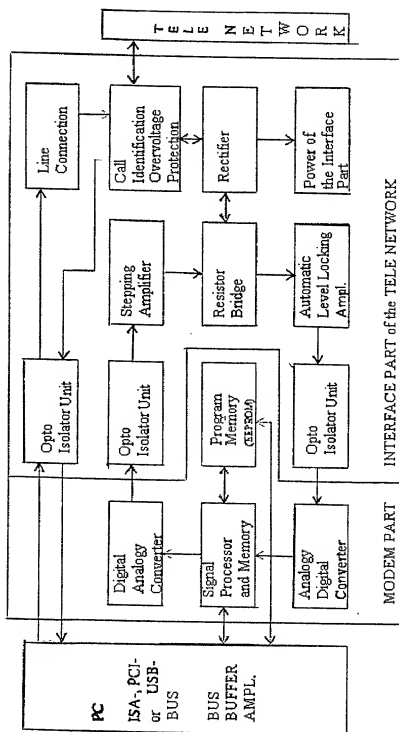


Fig.1

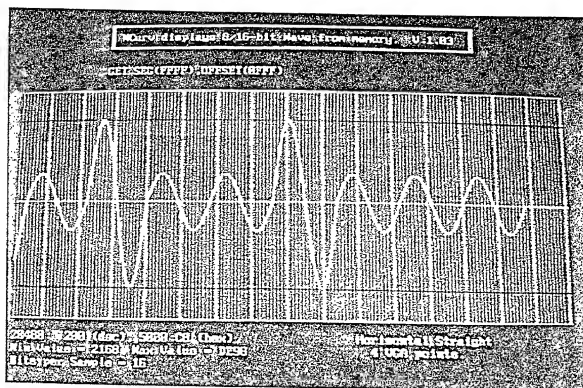


Fig.2

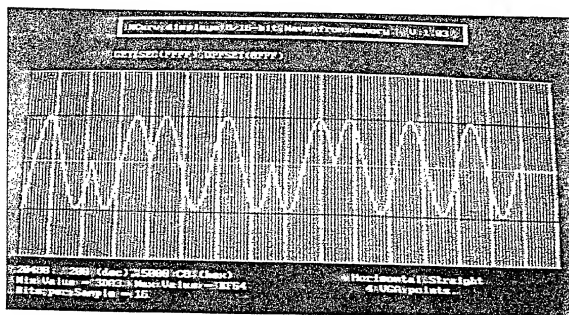


Fig.3

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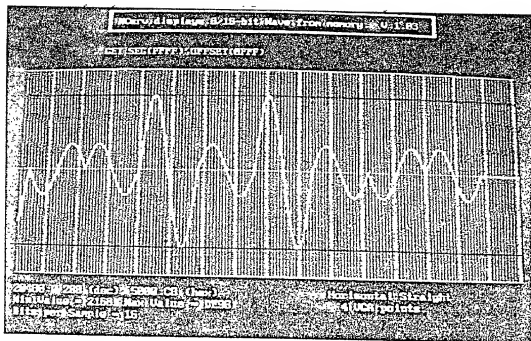


Fig.4

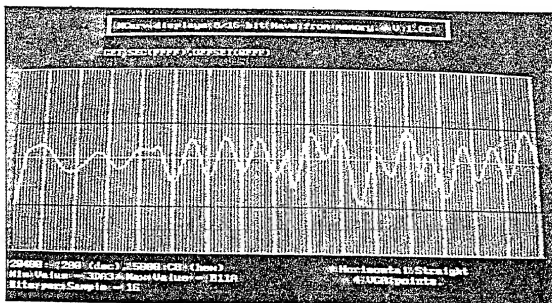


Fig.5

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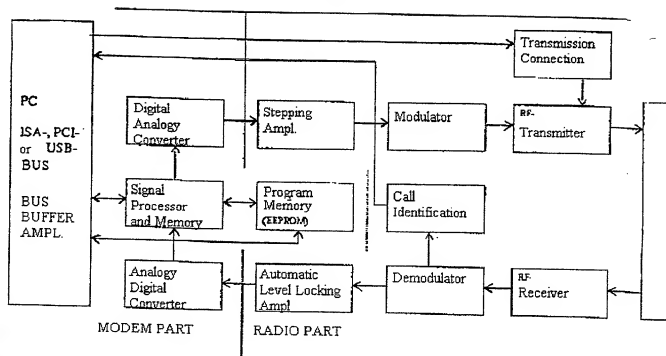


Fig.6

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent

In re patent application of: LALLO et al.

New U.S. Application

Examiner:

Based on PCT/FI99/00952

Filed: 16 May 2001

Art Unit:

For: ADAPTIVE MODEM AND METHOD FOR ADAPTIVE

Atty. Docket No.:

ELECTION OF MODULATION MODE

P07210US00/KRK

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Honorable Assistant Commissioner for Patents

Washington, D.C.

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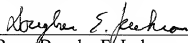
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Respectfully submitted,

Date: 16 May 2001

  
By: Douglas E. Jackson  
Registration No.: 28,518

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## DECLARATION FOR USA PATENT APPLICATION

(Including Design and National Stage PCT)

Attorney's Docket ID: \_\_\_\_\_

As a below signed inventor, I hereby declare that:

My residence, past office address and citizenship are as stated below adjacent to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **ADAPTIVE MODEM AND METHOD FOR ADAPTIVE ELCTION OF MODULATION MODE**

\_\_\_\_\_ the specification or which

☒ is attached hereto. (w)

was filed on \_\_\_\_\_ ( ) and was embodied on \_\_\_\_\_

☐ as U.S. Application No. \_\_\_\_\_ or

☒ as International PCT Application No. **PCT/FI99/00852**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 (a) - (d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 364 (b) of any PCT International application which designated at least one country other than the United States of America, listed below and have also identified below, where priority is not claimed, any foreign application for patent or inventor's certificate, or any PCT International application, having a filing date before that of this application by which priority is claimed:

Prior Foreign Applications: ( ) ADDITIONAL APPLICATIONS IDENTIFIED ON ATTACHED SHEET:

Number  
**982479**

Country  
**FI**

Day/Mon/Yr Filed  
**17/11/1998**

Priority Not Claimed

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 364(c) of any PCT International application designating the U.S., stated below; and insofar as the subject matter of each claim of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which becomes available between the filing date of this prior application and the national or PCT International filing date of this application. ( ) ADDITIONAL APPLICATIONS IDENTIFIED ON ATTACHED SHEET:

Application Serial No.

Day/Mon/Yr Filed

Status - patented, pending, abandoned

I hereby appoint the practitioners of **LARSON & TAYLOR** associated with the Customer Number provided below to prosecute this application and to conduct all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to that Customer Number.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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SEE ATTACHED SHEET FOR SIMILAR INFORMATION AND SIGNATURE FOR ADDITIONAL JOINT INVENTORS  
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